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Quarterly Report

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Contract Number: DTPH56-05-T-0003

Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Consolidated Research and Development Program to Assess the Structural Significance of Pipeline Corrosion"

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For quarterly period ending: June 30, 2007

Technical Status

1. Ring Expansion Tests

Ring expansion tests have been completed to generate stress versus strain curves for 48" diameter grade X100 pipe (from two different manufacturers). For all the ring expansion tests, failure occurred at the seam weld HAZ before reaching a strain value of 0.5%. The failures occurred from the toe at the weld cap on the inner side of the ring; little necking was observed prior to failure. All ring expansion tests on both 52" and 48" diameter grade X100 pipe have been completed. It was concluded that for all the rings tested, the yield strength was greater than the specified minimum value of 100ksi (689 MPa) for a grade X100 equivalent pipeline material.

2. Small Scale (Miniature) Tests

The small scale (miniature) testing program agreed with the external test house (GKSS – Institute of Materials Research) has been completed. The tests were conducted on 48" and 52" diameter X100 pipe (three manufacturers). Tests were undertaken with specimens extracted from both the longitudinal and transverse directions at the 3 o'clock and 6 o'clock positions (seam weld positioned at 12 o'clock positions). A total of 120 test specimens were produced using EDM (40 from each pipe) numbered from one to ten, one being closest to the outer pipe surface and ten being closest to the inner surface.

Stress versus strain curves have been generated for using the 120 test specimens. It has been observed that the yield strength obtained using the micro flat tensile specimens are generally below the SMYS for X100 pipe. Discussions with the test house (GKSS) indicate that deformation and the stress-strain behavior may have been affected by the micro-structural constituents of the test specimens or cracking at structural discontinuities. The results from the micro flat tensile specimens only provide the relative change in material properties thru the pipe wall. Additional calibration of the results from micro flat tensile specimens is required using standard round bar tests; this additional calibration will be undertaken in the next quarter.

3. Vessel Burst Tests and FE Analysis

Two vessel burst tests have been completed on 52" diameter grade X100 pipe. For both vessels, axially orientated groove defects were machined onto the external surface of the pipe. An example of a fabricated and instrumented test vessel is shown in Figure 1.

Figure 1 Fabricated 52" Diameter Test Vessel

Non-linear finite element analyses have also been completed to model the tests using stress versus strain data for X100 material from a previous PRCI project. Figure 2 shows a quarter symmetry model generated for predicting the failure pressure with a long groove defect (2000mm/78.7"). A similar model was generated for the for shorter groove defect (745mm/29.3").

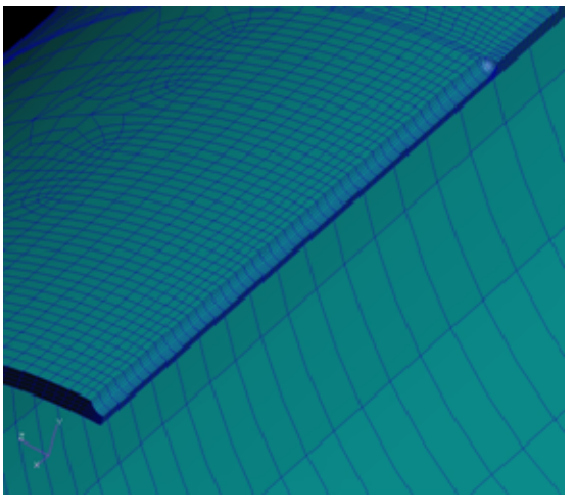

Figure 2 Quarter Symmetry Finite Element Model of the Vessel with a 2000mm/78.7" Long Groove Defect

A preliminary assessment shows that failure predictions using FE analysis are in good agreement for the shorter defect, but non-conservative for the longer defect. ASME B31G is conservative for both defects and RSTRENG is marginally non-conservative but in better agreement with the actual failure pressure. Further investigation and analysis of these results will be undertaken when the results from the miniature flat tensile and round bar specimens is undertaken in the next quarter.

4. Review of the Remaining Strength of Corroded Pipelines and Assessment of Deep Defects in Higher Strength Pipelines

A Draft Report (Advantica Report Number 6781) has been issued for comment to PHMSA and PRCI. The following was concluded:

- The ASME B31G and Modified ASME B31G methods can give non-conservative failure predictions, particularly for assessing relatively deep defects (greater than 60% of the pipe wall) in line pipe of strength grades X60 and above.
- The RSTRENG method is the most accurate method for predicting the failure pressure in pipelines. RSTRENG predicts failure pressures conservatively for defect depths up to 80% of the pipe wall in line pipe of strength grades up to X100.
- The SHELL92 method, which is a modified version of the ASME B31G method, conservatively predicts failure pressures for defect depths up to 80% of the pipe wall in line pipe of strength grades up to X100.

Payable Milestones

The following payable milestones were completed during this reporting period:

- Burst Tests on 52" Diameter Grade X100 pipe (Task 9, Item 17)
- Analysis and Assessment of Burst Tests (Task 14, Item 18)
- Small Scale Tests on 52 inch Grade X100 pipe (Task 10, Item 19)

- Small Scale Tests on 48 inch Grade X100 pipe (Task 12, Item 20)
- Draft report on assessment of deep defects in higher strength pipe (Task 19, Item 21)
- Ninth Quarterly Status Report Submitted

Plans for Future Activity

Agree on the scope of and conduct non-linear FE analysis cases with the PRCI project team for assessing corrosion damage in grade X80 and X100 pipelines subjected to pressure and axial/bending loading.